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Memorandum

To: Chehalis River Basin Flood Authority

From: Larry Karpack, WATERSHED Science & Engineering (WSE)

Date: 1/13/2012

Re: **Hydrologic Data Development Recommendation**

Task 6 of the "Detailed Work Plan" for the Lower Chehalis River Hydraulic Model Development Project noted that it might be necessary to conduct additional hydrologic analyses, beyond those being conducted by WEST Consultants for the Corps of Engineers, to support the Flood Authority's current hydraulic modeling efforts. WEST's work for the Corps included analysis of flood flow frequency relationships at all significant gaging stations in the Chehalis River basin and the development of hydrographs representing the 1.5-, 2-, 5-, 10-, 20-, 50-, 100-, 200-, and 500-year flood events in addition to various "ecologically significant" flows at more than 70 locations throughout the basin. WEST is also developing hydraulic model inputs for the main stem Chehalis River. WEST's work has been delivered and is currently under review by the Corps and a number of independent reviewers.

The initial work plan for the Flood Authority hydraulic model development project anticipated using WEST's hydrologic analysis without adjustment. While that approach may still be desirable, there are two issues with doing so that need to be considered. First, the hydrologic data developed by WEST will be different from data previously used in the Twin Cities hydraulic model. Second, the data developed by WEST would not be directly applicable for certain future studies, for example, FEMA floodplain mapping studies, because of differences between Corps and FEMA approaches. Each of these issues is described more fully below.

There are several reasons that the data being developed for the Corps by WEST is different from data previously used in hydraulic modeling for the Lewis County FEMA study, the Twin Cities levee project, and the preliminary evaluation of upstream water retention facilities. First, the period of record being used by WEST extends several years beyond the period of record used by Northwest Hydraulic Consultants (NHC) in the 2010 FEMA floodplain mapping study. This is often the case when new studies are conducted and generally does not result in significant differences in the flow data. However, in the case of the Chehalis River basin, the extended data set includes a large flood event in January 2009 and as such, the differences in here might be greater than in other studies. A second reason that the WEST hydrology differs from the previous studies is due to differences in methodologies including the gages selected for data transposition, transposition methods, scaling factors, and hydrograph development techniques. Differences in methodologies also include the second issue, differences in frequency analysis between the Corps and other agencies (e.g. FEMA), as describe below.

In conducting frequency analysis the US Federal Government "standard" is to use guidelines published in a document called "Bulletin 17B". WEST is doing this for the Chehalis Basin under their contract for the Corps. However, in the Corps implementation of the Bulletin 17B guidelines they use an adjustment to the flood frequency quantiles called the "expected probability adjustment". This adjustment, which is described as optional in Bulletin 17B, recognizes that sample sizes for peak flow data sets are generally small and makes a statistical adjustment to the flows to account for this. The rationale is that the adjustment results in conservatively high values, which are appropriate for flood damage reduction project design. FEMA and many other agencies, on the other hand, do not use the expected probability adjustment because their goal is to obtain the most defensible estimates of flood flow frequency quantiles (not the most reasonably conservative).

The difference in the 100-year flood flow as a result of the “expected probability adjustment” can range from negligible (less than 1%) to 10% or more. Generally, in a basin such as the Chehalis River basin, with long observed gaging records, the difference will average about 2%-5%. For example, at the downstream end of the Twin Cities model at Grand Mound the expected probably adjustment would increase the estimated 100-year discharge from 75,400 cfs to 77,800 cfs.

Considering the issues described above there are several ways to proceed with developing hydrologic data for the Flood Authority study, including the following:

1. Use the hydrologic data previously developed by NHC for the Twin Cities portion of the model (downstream as far as the Lewis-Thurston County line) and then use the new data being developed for the Corps by WEST for the downstream study reach.

   Benefits of this approach: consistent with previous modeling in Lewis County, consistent with Corps analysis in lower Chehalis requires no additional expenditure.

   Disadvantages of this approach: lack of consistency in data development approaches across the basin, inconsistent with Corps analyses in upper basin, not applicable to flood damage reduction projects, not applicable to FEMA studies in lower basin.

2. Use the Corps hydrology as developed by WEST, which includes the expected probability adjustment, for the entire basin.

   Benefits of this approach: homogeneous development approach across entire basin, consistent with Corps analyses, applicable to flood damage reduction projects, requires no additional expenditure.

   Disadvantages of this approach: Different from previous modeling in Lewis County, not applicable for FEMA studies.

3. Compute a second set of hydrologic data for the entire basin that does not include the expected probability adjustment. The unadjusted data (called the "computed" values in Bulletin 17B parlance) would be required if the current modeling was to be used for FEMA mapping at some time in the future.

Benefits of this approach: homogeneous development approach across entire basin, consistent with previous FEMA analyses in Lewis County, applicable to FEMA flood studies.

Disadvantages of this approach: Additional cost for developing a second set of hydrologic data, inconsistent with Corps analyses in upper basin, not applicable to flood damage reduction projects.

WSE's recommendation is to use alternative 2 or 3, depending on whether updated FEMA mapping is a near term goal of the Flood Authority. If the Flood Authority anticipates wanting to develop or update FEMA maps in the near future alternative 3, with an estimated cost of about $7,000, would be the recommended option. Otherwise, alternative 2 would seem to be equally appropriate for the current hydraulic modeling effort. As noted above the difference between the 100-year flood flows under the various alternatives would be relatively small, generally less than 5%. As such, and because all hydraulic analyses done for this study will be based on a single hydrologic data approach, the general conclusions of this study are not expected to be affected by the choice of data development approach although the absolute magnitude of any particular result (e.g. 100-year water level) would vary. Alternatives 2 and 3 are both internally consistent which WSE believes is a compelling reason to prefer these over alternative 1.